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# *Theoretical pressures and in vivo pressures: practical consequences of Laplace's law*

## *Laplace's law: theoretical pressures*

The localised static pressure exerted on the leg by a compression system can be calculated overall using Laplace's law:

$$P = \alpha \frac{T/W}{R}$$

P is the interface pressure (in mmHg or hPa)
T/W is the tension (N) by width unit
R is the radius of the leg (m)
α is the proportionality coefficient

In practice, the radius of the leg cannot be easily measured, so the circumference is used instead; in addition, it is necessary to take into account the bandage application method; finally, the pressure is expressed in mmHg; which gives the final equation:

$$P = \frac{T \times N \times 4630}{C \times W}$$

P is the interface pressure under the bandage (in mmHg), also called the compression force
T is the tension of the bandage (Kgf), which depends on the material and its stretch %
N is the number of layers (defined by the level of overlap and the number of bandages)
C is the circumference at the measurement point (cm)
W is the bandage width (cm)

P is the localised static pressure exerted at a given point by the textile material. This localised static pressure depends on: .

the intrinsic technical characteristics of the bandage

its application method

the patient (circumference at the measurement point at time t)

## *Relationship between Laplace's law and in vivo pressures*

It is necessary to know the influence of these parameters and, above all, to understand the consequences in terms of pressure variation:



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**Influence of limb circumference:** independently of other factors, the more this increases, the more the pressure decreases. It is therefore essential to take into account this parameter and hence individual and inter-individual variations;

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influence of bandage tension: the more a bandage is stretched, the more the pressure applied to the leg will increase read more

variation in number of layers: a bandage applied using the figure of 8 method with a 50% overlap will apply the equivalent of 4 layers whereas a bandage applied using the spiral method with a 50% overlap will apply the equivalent of 2 layers, i.e. a pressure that is twice as high in the former case, all other parameters being equal read more

influence of bandage width: theoretically, a bandage with a width of 8 cm will apply a slightly higher pressure than a bandage with a width of 12 cm, all other parameters being equal. read more

A variation in the different parameters involved in Laplace's law therefore modifies the compression force applied to the patient's leg and may detrimentally affect the effectiveness of the treatment or even make it dangerous.

Laplace's law therefore demonstrates the importance:

- for manufacturers, of defining a precise application method for their bandages or compression systems
- and for operators, of training and practice to ensure they have fully mastered the application method,

The objective being to limit the operator-dependent effect as much as possible, thereby limiting the risks of insufficient or excessive pressure, which can sometimes have serious consequences.

**Important: Since Laplace's law theoretically assesses a localised static pressure, it is important not to forget the influence of patient mobility on dynamic pressures (see chapter on compressive effects depending on bandage type).**

## *Anatomical realities of patients*

**Degressive pressure gradient from the foot to the thigh**



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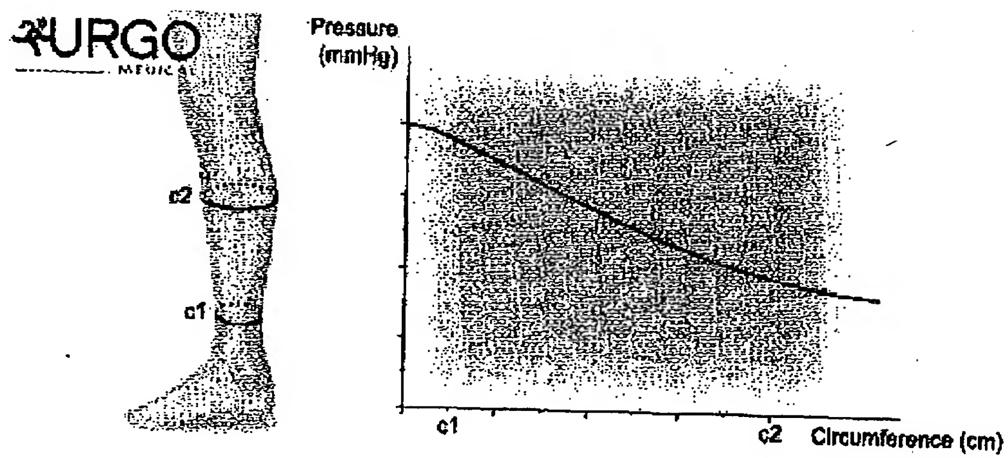
In the absence of any compression, there is a natural haemostatic gradient in the lower limb, which is degressive from the foot to the thigh. It is necessary to respect this degressive gradient when applying compression.

In a lower limb with a normal morphology (in the shape of a truncated cone), the degressive pressure gradient is obtained naturally thanks to the gradual increase in leg diameter from the ankle to the knee or thigh.




According to Laplace's law, in the absence of variations in the other factors, if the circumference of the leg increases, there is an inversely proportional decrease in pressure. In other words, under compression, the degressive pressure gradient is guaranteed by a normal leg morphology.

**Sensitive locations and atypical morphologies**

According to Laplace's law, on bony prominences, such as the Achilles tendon or shin bone, the pressures exerted will be greater than those on flat or hollow zones, such as the zone behind the malleolus, since the radius of these prominent zones is much smaller than that of the limb.

To ensure safe and effective compression, it is necessary to restore an even conical shape to the leg, filling in hollows and rounding off prominent zones using pads, wadding bandages or foam.
This phase is essential to prevent zones of excessive pressure that could potentially cause local tissue ischaemia and necrosis.



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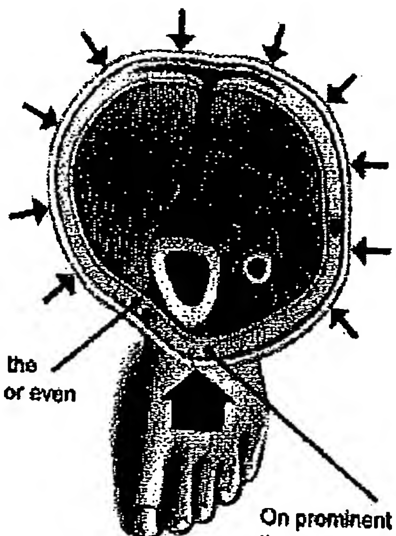
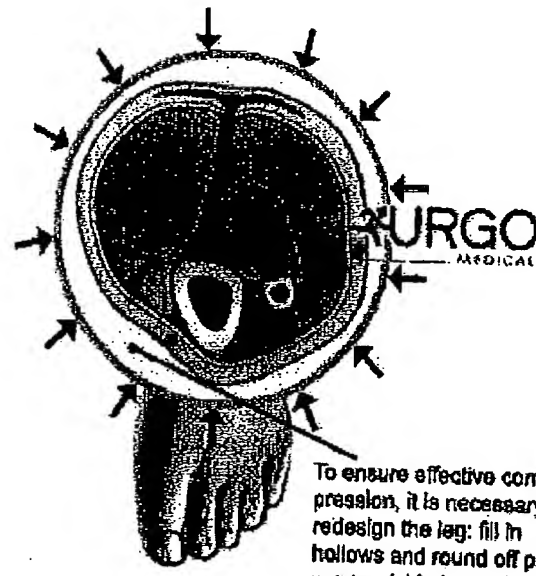
Less commonly, some patients who need to wear a compression system may present atypical leg shapes: column-shaped legs, very wasted muscles in a particular area of the leg, etc. This mostly concerns elderly, malnourished patients presenting an ulcer and/or severe trophic changes.

So it is necessary to restore a normal leg shape in these patients before applying the compression system in order to apply even pressure respecting a degressive pressure gradient.





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